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Our experience regarding types of atherosclerosis plaques in coronary arteries and their relation to degree of stenosis in King Hussien Hospital

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Abstract
Purpose: The aim of the study to evaluate the different types of plaques in the coronary arteries and their relation to degree of stenosis.
Methods: our retrospective study include2425 patients, aged 18-75 years, of both sexes, with history of chest pain at King Hussein Hospital during the 2018-2020 period. All the patients' outcome was plaques of different types, causing wide ranges of stenosis from non to total occlusion.
Results: Entirely calcified plaques was recorded in1333 patients (55%), partlycalcified plaques was recorded in 606 patients (25%), non-calcified plaques recorded in 486 patients (20%). significant and high grade stenosis almost found in partly and non-calcified plaques.
Conclusions: Coronary artery disease is leading cause of death in western world, it is caused by buildupplaque that cause narrowing of the artery lumen and thus decrease of the oxygen supply to cardiac muscle. The most common type of coronary plaque is entirely calcified but the risk of obstructive >50% stenosis found in partly and non-calcified plaques rather than totally calcified plaques.

Keywords: coronary artery disease, coronary CT angiography, calcified plaques, coronary artery stenosis

Introduction
Coronary artery disease (CAD) is the leading cause of death in the western world [2], On 30 October 1958, the first coronary angiography was performed by Sones, shortly after that CT angiography became the gold standard in the evaluation of the coronary artery disease [3]. As it allowed a visual estimation of the presence of plaques, percentage of stenosis and presence of congenital malformation or acquired diseases. However it is non-invasive procedure with a small risk of fatal events or complications.

Materials and Methods
This is a retrospective study for adult patients of both genders, who were found to have plaques in their Coronary CT angiography at King Hussien Medical Hospital. All patients were scanned with SIEMENS CT (Somatom Force) 256-slice in the period from February 2018 to January 2020. we included only patients with positive plaque finding regardless of the type, size and coronary luminal stenosis, excluding normal reports, patients with history of coronary artery bypass graft or prior percutaneous coronary intervention PCI and patient with high or irregular heartbeats or with inability to comply with instructions of breath holding, patients with heavy calcification and high calcium score (high Agatston score) were excluded, patients with Obesity and good quality images were enrolled in this study. preparation of the patients include Renal function test to assess creatinine level and measurement of heart rate prior to imaging, patients with excessive motion artifacts were excluded from this study. The exam started by the patient holding breath while the images were obtained and intravenous contrast was given. the contrast transit time was estimated by injection of test bolus or using a real-time bolus tracking technique, the images was viewed in axial plane, oblique multiplanar reconstructions MPR, oblique maximum intensity projections MIPs, curved multiplanar reformations cMPRs and volume rendering 3-Dimensional reconstruction technique using Syngo-via software. All patients were examined by two radiology specialists in two separate sessions and the results were analyzed by simple statistical methods.

Results
Our study revealed that more than 55% of patients showed entirely calcified plaques, the majority of these plaques didn't cause significant stenosis (the stenosis was less than 70%), so further investigations were unnecessary. while the partly and non-calcified plaques founded in 25% and 20% respectively caused wide range of stenosis from non-significant to total occlusion.

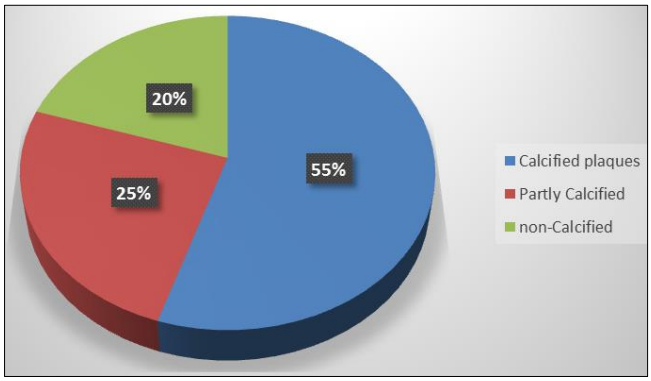


Fig 1: percentage of type of plaques

Regarding to the stenosis our study revealed that 45% of the patient shows no stenosis, while 12% showed minimal stenosis, 15% mild, 10% moderate stenosis, 13% severe stenosis, 5% showed total occlusion.

Qualitative severity	Implication
Normal	Absence of plaque and no luminal stenosis
Minimal	Plaque with < 25 % stenosis
Mild	Plaque with < 25 %–49 % stenosis
Moderate	Plaque with 50 %–69 % stenosis
Severe	Plaque with 70–99 % stenosis
Occluded	Total occlusion

Fig 2

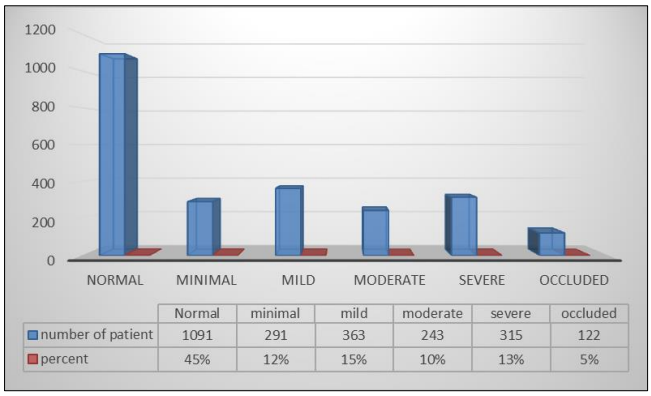


Fig 3

Fig 4: total occlusion caused by non-calcified plaque

Discussion

What is coronary artery disease, it is disease caused by atherosclerosis plaque buildup inside the artery wall causing narrowing of the artery lumen and decrease oxygen supply to the cardiac muscle, plaque is made of several substances including cholesterol. As plaque continues to build up signs and symptoms including Chest pain (angina), Shortness of breath and heart attack may develop, rupture of the plaque leads to myocardial infarction.

In the early stages the sequence of CAD is predictable, specific, uniform and asymptomatic, the patients may be asymptomatic due to the presence of non-significant stenosis <50% of the lumen or collateral circle blood supply, furthermore associated diseases such as diabetes may hide clinical symptoms of CAD.

Coronary artery stenosis is most commonly evaluated according to the degree of vessel diameter reduction compared to apparently normal proximal and distal artery segment

In Coronary CT angiography, plaques can be classified as entirely calcified (the entire plaque appears as calcium density), partially calcified (plaque with two component of which one of them is calcification), non-calcified (no calcium content). Coronary artery stenosis can be caused by all these types. Non-calcified and partly calcified lesions can cause severe luminal stenosis more frequent than entirely calcified plaque.

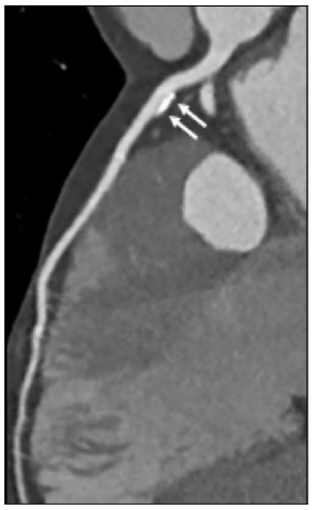


Fig 5: Calcified plaque

Fig 6: Partly calcified plaque

Fig 7: Non-calcified plaque

Calcified plaque: is atherosclerotic plaque in which the entire plaque appear as calcium density (>130HU on non-enhanced study).
Partly calcified plaque: is atherosclerotic plaque lesion with two components in which one of them is calcification.
Non-calcified plaque is a plaque with no calcium content.
Coronary arteries plaques divided histologically into stable and vulnerable plaques, Stable plaques: are characterized by large calcifications, fibrotic tissue and smaller lipid pools.
Vulnerable plaques: contain spotty calcifications, large lipid pool (necrotic core) which is covered by a thin fibrous cap, these plaques sometimes referred as thin cap fibrotheroma TCFA (figure 4) vulnerable plaques are more prone to rupture due to disruption of the thin fibrous cap

Fig 8: Stable and vulnerable plaques

Positive remodeling is defined as a compensatory outward enlargement of the vessel wall at the site of atherosclerotic lesion with preservation of the coronary lumen [4]. On histology plaques with positive remodeling show a higher lipid content and abundance of macrophages and can present with an acute coronary syndrome without prior cardiac history [5]

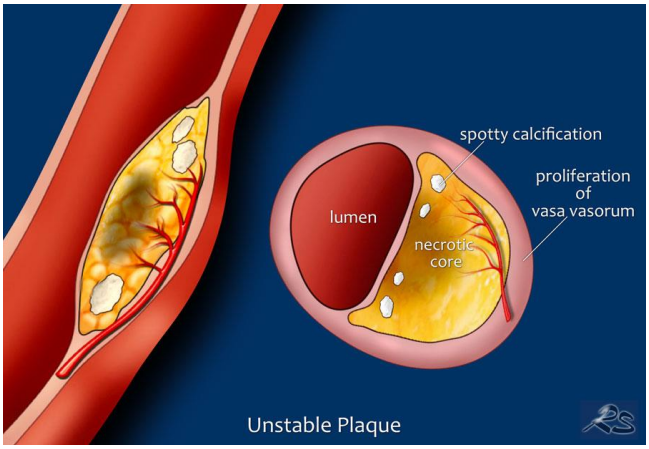
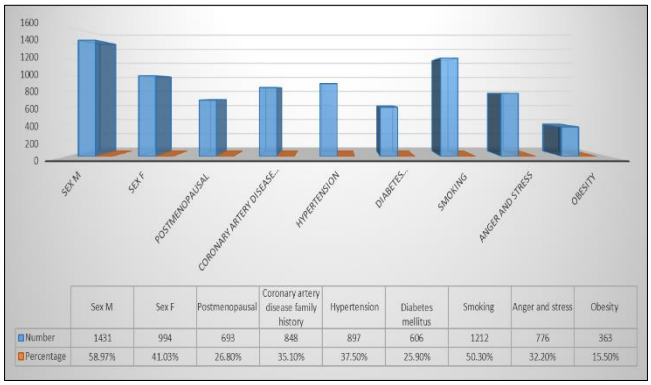


Fig 9: Positive remodeling in unstable plaque

The six main risk factors for coronary arteries plaques formations are:
Smoking, High LDL or bad cholesterol and low HDL or good cholesterol, uncontrolled hypertension, uncontrolled diabetes, physical inactivity, obesity, uncontrolled anger and stress.
There is no relation between the volume of the coronary atherosclerotic plaque and the severity of associated luminal stenosis, very small amounts of plaques can cause severe stenosis and may not easily visualized especially in the setting of elevated image noise, on the other hand even very large atherosclerotic plaque can be found with only minimal luminal reduction or the entire absence of it [6].
Also there is no close relationship between the anatomic degree of stenosis severity and the hemodynamic relevance of a coronary atherosclerotic lesion. Even severe luminal stenosis especially when short do not necessarily cause stress induced ischemia, whereas stenosis of a lesser degree especially when long can be associated with relevant ischemia [6].

Table 1: Patient demographics in this study with the risk factors.

Item	No (%)
Age (yrs.) median (range)	18-75 (46)
Sex Male Female	1431 (58.97%) 994 (41.03%)
Postmenopausal	693 (26.8)
Coronary artery disease family history	848 (35.1)
Medical history Hypertension Diabetes mellitus	897 (37.5) 606 (25.9)
Smoking	1212 (50.3)
Anger and stress	776 (32.2)
Obesity	363 (15.5)
Hyperlipidaemia	582 (24.6)



	Sex M	Sex F	Postmenopausal	Coronary artery disease family history	Hypertension	Diabetes mellitus	Smoking	Anger and stress	Obesity
Number	1431	994	693	848	897	606	1212	776	363
Percentage	58.97%	41.03%	26.80%	35.10%	37.50%	25.90%	50.30%	32.20%	15.50%

Fig 10: Patient demographics.

Conclusion

Coronary artery disease is leading cause of death, the most common cause of coronary artery disease is plaque formation, there are three types of plaques: calcified which is the most common, partly and non-calcified plaques which carries the high risk of significant stenosis and obstruction. Coronary CT angiography has excellent ability to rule out coronary stenosis caused by plaques.

Conflict of interest: None.
Funding source: None.

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